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# Metal oxides as electrode materials for electrochemical capacitors

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A thesis submitted in fulfilment of the
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# Certification

I, Zhuo Jin Lao, declare that this thesis, submitted in fulfilment of the requirements for the award of Master of Engineering - Research, at the Institute for Superconducting and Electronic Materials, Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

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# Contents

# Abstract

Electrochemical capacitors are becoming attractive energy storage devices and fill the gap between batteries and conventional capacitors because they have higher energy density than conventional dielectric capacitors and have higher power density and a longer cycling life than batteries. In this study, transition metal oxides, such as $Co_3O_4$, NiO, $V_2O_5$ and $MnO_2$, have been successfully synthesized by different chemical-based solution methods. Their physical properties were characterized by X-ray diffraction, SEM, and BET analysis. The as-prepared $Co_3O_4$, NiO, $V_2O_5$ and $MnO_2$ were investigated as electrode materials for electrochemical capacitors and demonstrated very high specific capacitances, which were 168 F/g, 203 F/g, 262 F/g, and 406 F/g, respectively. This may be due to their large surface areas ($Co_3O_4$ (82 $m^2/g$), NiO (90 $m^2/g$), $V_2O_5$ (41 $m^2/g$) and $MnO_2$ (269 $m^2/g$)) and pseudocapacitive behaviour. Compared with expensive $RuO_2$, which has been used extensively as electrode material for electrochemical capacitors, the as-prepared $Co_3O_4$, NiO, $V_2O_5$, and $MnO_2$ are much cheaper. This makes them very promising candidates as electrode materials for electrochemical capacitors.